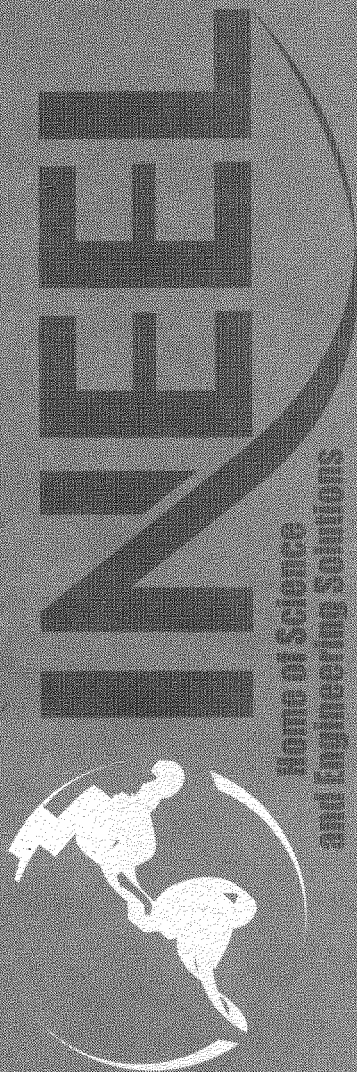


Fiscal Year 2002 Summary Report for the OU 7-13/14 Probing Project

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April 2003*



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April 2003

**Idaho National Engineering and Environmental Laboratory
Environmental Restoration Program
Idaho Falls, Idaho 83415**

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ABSTRACT

The Waste Area Group 7 Operable Unit 7-13/14 Probing Project captures field, electronic, and analytical data generated to support the Operable Unit 7-13/14 remedial investigation/feasibility study and a Record of Decision. The types of data included in this activity include data generated from analytical samples (both lysimeter [liquid] and soil vapor probe [gas]), nuclear logging activities, real-time in situ monitoring devices (tensiometers and soil moisture probes), and visual images of waste zones (borehole video and optical televiewer) within Operable Unit 7-13/14. This report documents and summarizes the data generated and collected in the Operable Unit 7-13/14 Probing Project during Fiscal Year 2002.

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ACRONYMS

C-14	Carbon-14
ECL	Environmental Chemistry Laboratory
ENSDF	evaluated nuclear structure data file
FY	fiscal year
GC/MS	gas chromatography/mass spectrometry
H-3	tritium
ID	identifier
INEEL	Idaho National Engineering and Environmental Laboratory
L&V	limitation and validation
MCNP	Monte Carlo physics code evaluation
MDA	minimum detectable activity
OU	operable unit
PCE	tetrachloroethene
PVC	polyvinyl chloride
RBC	risk-based concentration
redox	reducing/oxidizing
RFP	Rocky Flats Plant
RI/FS	remedial investigation/feasibility study
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SMR	soil moisture and resistivity
SVR	soil vault row
SWLO	Southwest Laboratories of Oklahoma
SWRI	Southwest Research Institute
TCA	1,1,1-trichloroethane

TCE	trichloroethene
TPR	technical procedure
TRU	transuranic waste
VOC	volatile organic compound
WAG	waste area group

Fiscal Year 2002 Summary Report for the OU 7-13/14 Probing Project

1. INTRODUCTION

1.1 Purpose

The field, electronic, and analytical data generated for the Waste Area Group 7 Operable Unit (OU) 7-13/14 Probing Project during Fiscal Year (FY) 2002 are summarized in this report. The types of data addressed in this report include data generated from the analysis of lysimeter samples (liquid) and soil vapor probe samples (gas); data from nuclear logging activities, real-time in situ monitoring using tensiometers, and soil moisture probes; and data from visual probe images of waste zones (borehole video and optical televiewer) within Operable Unit 7-13/14. The OU 7-13/14 Probing Project is being conducted in the Subsurface Disposal Area (SDA) of the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering and Environmental Laboratory (INEEL) to support the OU 7-13/14 Remedial Investigation/Feasibility Study (RI/FS) leading to a Record of Decision. Waste Area Group (WAG) 7 is the designation for the RWMC, recognized under the Federal Facility Agreement and Consent Order (DOE-ID 1991) and the Comprehensive Environmental Response, Compensation, and Liabilities Act (42 USC § 9601 et seq., 1980).

1.2 Scope

The documentation for the OU 7-13/14 Probing Project includes the *Probehole Plan*, *Field Sampling Plan*, and *Data Management Plan*. *Operable Unit 7-13/14 Plan for the Installation, Logging, and Monitoring of Probeholes in the Subsurface Disposal Area* (INEEL 2000) is the initial planning document for the OU 7-13/14 Probing Project and is a plan for two phases of probing. The first phase is the installation of Type A probes that are installed in selected focus areas in the SDA and provide access to the subsurface for nuclear logging. The data from the logging of the Type A probes provide information for the selection of locations for Type B probes to be installed as the second phase of the probing project. *Field Sampling Plan for Monitoring Type B Probes for the Operable Unit 7-13/14 Integrated Probing Project* (Salomon 2001) describes how and where Type B probes will be installed, how samples will be collected from the Type B probes, and how the Type B probes will be monitored. *Data Management Plan for the Operable Unit 7-13/14 Integrated Probing Project* (INEEL 2002) describes the process for the capture and maintenance of all field, electronic, and analytical data generated in the OU 7-13/14 Probing Project. The data within the scope of this summary report are the data derived from the probes installed in the SDA, which are Type A Probes (nuclear logging) and Type B probes (soil vapor probes, lysimeters, tensiometers, soil moisture probes, and visual probes).

1.3 Background

The OU 7-13/14 Probing Project has been involved in the designing, constructing, installing, and monitoring of Type A and Type B probes in the SDA. This work is conducted to support the OU 7-13/14 RI/FS study process and achieve a Record of Decision. Monitoring within the waste zone is a unique application of these technologies at the INEEL. All previous monitoring at the SDA has been between waste disposal locations or at depth in sedimentary interbeds. Table 1 contains additional detail on the types of probes and the data collected by the probes.

Table 1. Types of data collected for the Operable Unit 7-13/14 Probing Project.

Data Source	Data Type	Data Examples
Type A probes: downhole nuclear logging tools	Digital files — counts per second and energy levels	Single event digitally collected logs from the following instruments: <ul style="list-style-type: none"> • Passive gamma detector for identifying gamma-emitting sources • Neutron activation instrument to detect prompt gamma from C1-35, an indicator for halogenated hydrocarbons • Neutron-neutron detector to evaluate soil moisture • Passive neutron detector for detecting transuranic radionuclides • Shielded, directional gamma detector to identify azimuthal location of gamma-emitting sources
Type B probes: tensiometers	Matric potential in a soil matrix	Pressure data collected initially on data loggers Ambient pressure (centimeter of water) Gross matric potential (centimeter of water)
Type B probes: soil moisture probes	Relative moisture content in the surrounding material	Moisture content (percent by volume), resistivity (ohm-meters), dielectric constant (MHz), and temperature data (°C) collected initially on data loggers
Type B probes: lysimeters	Analytical results	Analytical sample results
Type B probes: visual probes	Video recordings, optical televiewer, and digital images	Video recording and potentially digital stills taken as downhole optical logs
Type B probes: vapor ports	Analytical results	Volatile organic compound concentrations (from field instruments and laboratory gas chromatography/mass spectrometry analyses) from vapor ports located within the pits Radioactive gas (Carbon-14 and tritium) laboratory samples from vapor ports located next to soil vaults

Type A probes are steel pipes fitted with a drive point, installed in the waste zones. The probes allow nuclear logging instruments to be lowered to the subsurface (inside the uncontaminated pipe) so that nuclear sources and nuclear detection devices can record nuclear spectral data from the waste zone. Type A probe data, generated by the nuclear logging instruments, have been used to select locations for many of the Type B probes.

Type B probes also are drilled into the landfill to collect physical samples (gas and liquid) or to collect in situ geotechnical data. Soil vapor probes are installed to collect soil gas samples from specific locations for laboratory analysis. Lysimeters are designed to extract soil moisture and provide a liquid sample for analysis. Tensiometers measure matric potential by sensing how tightly water is held in the soil. Soil moisture probes measure the temperature and electrical characteristics of the soil to determine soil moisture content. Visual probes are constructed from steel rods, stabilizers, tool joints, and Lexan tubes. The inside of the visual probes are open so visual images can be recorded from the inside of the

probe looking out through the Lexan tubes, which form the outside wall of the probes. Table 1 provides additional detail on the characteristics of the data collected by the Type A and Type B probes.

The general approach to the OU 7-13/14 Probing Project, including placement of original Type A probes, was outlined in *Operable Unit 7-13/14 Plan for the Installation, Logging, and Monitoring of Probeholes in the Subsurface Disposal Area* (INEEL 2000). The general approach established focus areas for investigation based on the shipping and inventory records. Type A probes were installed in transects to identify certain specific waste types and waste shipments. The Type A data were analyzed and used to establish the locations for individual and clusters of Type B probes.

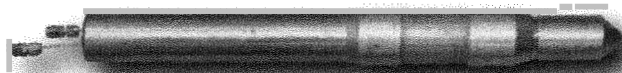
The installation and monitoring of the Type B probes are described in *Field Sampling Plan for Monitoring of Type B Probes in Support of the Integrated Probing Project Operable Unit 7-13/14* (Salomon 2001). Type B probes include tensiometers, suction lysimeters, vapor ports, visual probes, and soil moisture probes. Three hundred and thirty-seven Type A and Type B probe and instrument packages were installed in the SDA as part of the probing project between December 1999 and November 2001. Specific numbers of the types of probes include:

- 66 tensiometers.
- 78 soil moisture probe instruments (51 physical probes, some being multiinstrumented).
- 30 vapor ports.
- 18 lysimeters
- 10 visual probes.
- 135 Type A probes, which excludes 10 probes not logged because of shallow completions (less than 2 m [6 ft 3 in.]). Five of the shallow probes were replaced with deeper probes, which were logged.

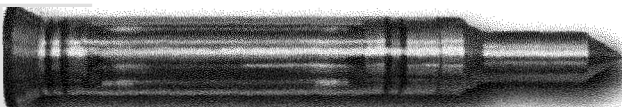
The types of probes used in the OU 7-13/14 Probing Project are illustrated in Figure 1. Figure 2 provides a view of a typical probe suite. Appendix A contains maps representing the surveyed locations of Type A and Type B probes installed in the SDA. Data generated from these probes are being used to support assessment of infiltration through the waste, release rate and solubility of uranium, release rate of Carbon-14 (C-14), and mass of the volatile organic compound (VOC) source remaining. The results will support the OU 7-13/14 Probing Project and ultimately verify and validate the Comprehensive Environmental Response, Compensation, and Liability Act-based OU 7-13/14 comprehensive RI/FS. Operable Unit 7-13/14 is the comprehensive OU for WAG 7.

1.4 Document Organization

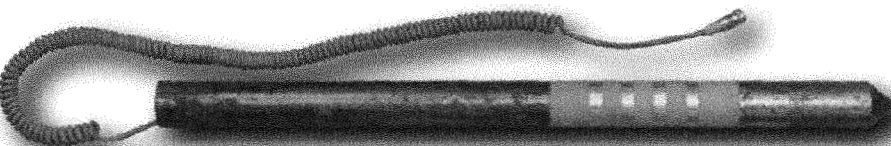
This document is organized by probe and the type of data collected by the probe. The Type B probes are presented first and are presented in the following order: soil vapor probe, lysimeter, tensiometer, soil moisture probe, and visual probe. The nuclear logging data from the Type A probes are presented last. Appendix A contains maps showing the focus areas and probes installed within the focus areas. Appendix B contains a table of probe attribute data (e.g., probe names, survey information, sample port depths, and various other support information compiled during installation). The appendixes following Appendix B contain supporting data for the Type A and the Type B probes.



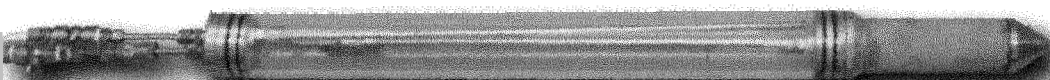
Vapor—detects and collects gas and vapor samples



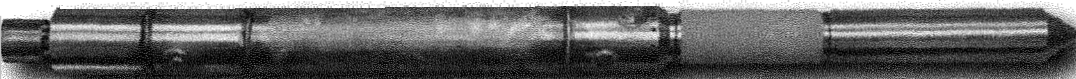
Visual—allows visual inspection of subsurface conditions (tip section only)



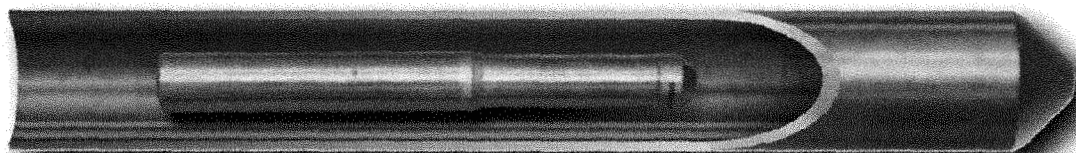
Soil Moisture—measures soil moisture content



Lysimeter—collects water/liquid samples (unit shown is a development model which has clear plastic in place of stainless steel wall components to show probe internals)



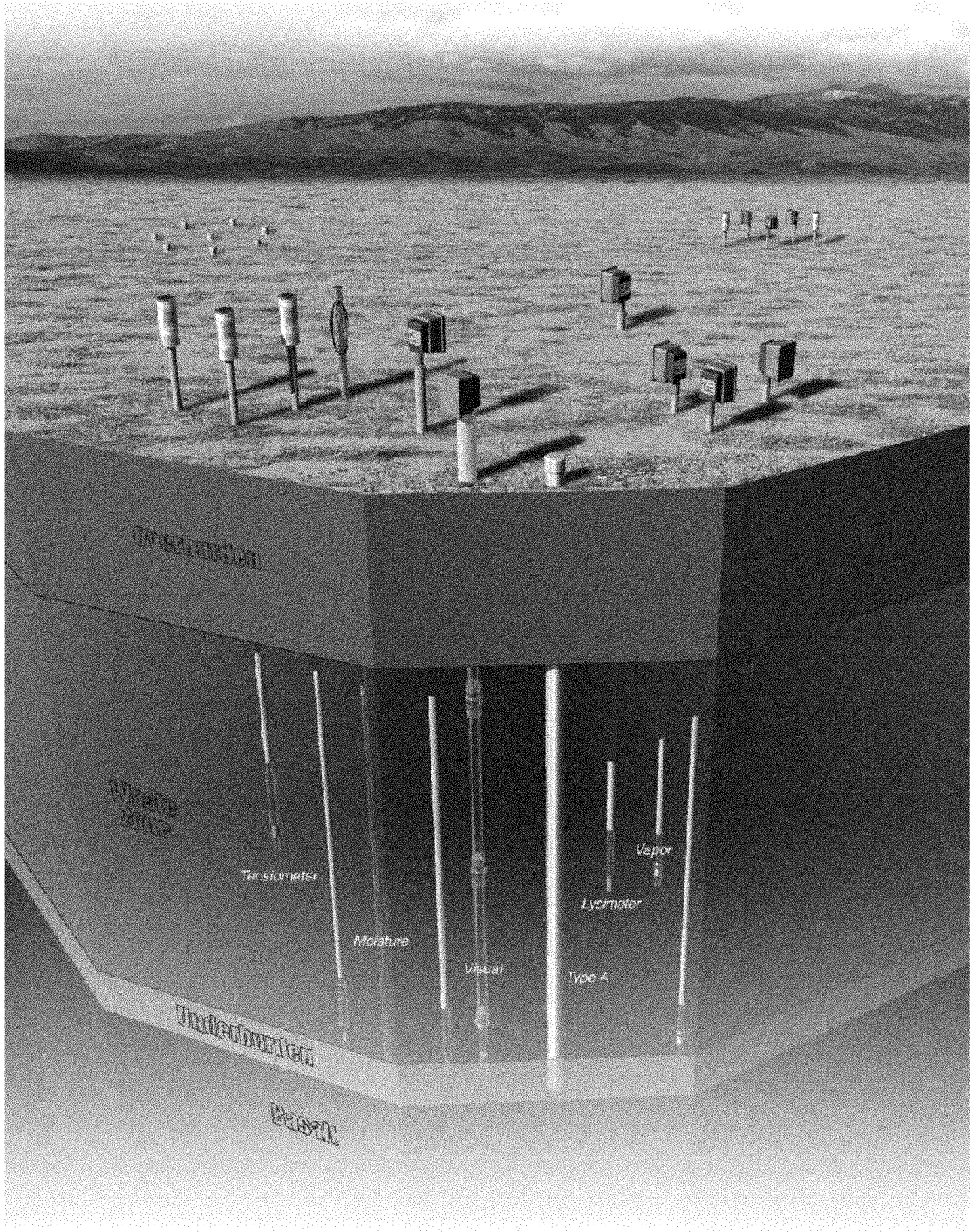
Tensiometer—measures movement of water



Type A—accommodates interchangeable logging tools that detect contamination

03-GA50310 03

Figure 1. Probe types used in the Operable Unit 7-13/14 Probing Project.



03-GA50310-04

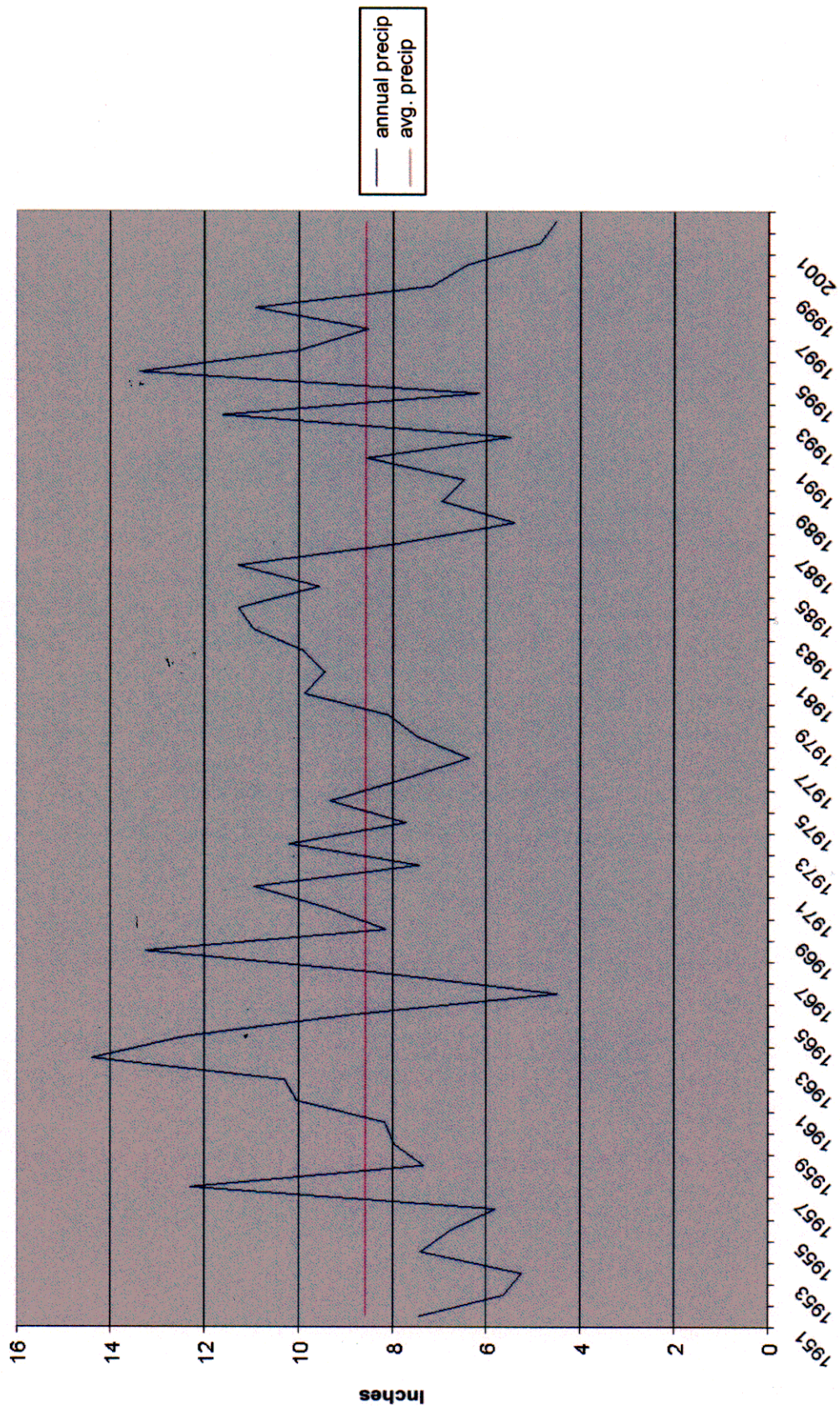
Figure 2. Typical probe suite installed in the Subsurface Disposal Area.

1.5 Meteorology

The lysimeters, tensiometers, and soil moisture probes all rely on the water in the soil to perform their function. While some instruments have had mechanical or electrical problems that have inhibited their ability to provide as much data as desired, the monitoring environment also has made in situ monitoring very difficult. The very dry soil conditions can be too dry to obtain a lysimeter soil moisture sample, require additional maintenance on tensiometers, and more difficult for soil moisture probes to measure resistance and conductivity. The INEEL site has experienced two of the driest years on record in 2001 and 2002 with 4.87 and 4.53 in. of precipitation, respectively, which have caused extremely dry waste zone conditions.”See Figure 3, which shows the annual precipitation since 1951. In 51 years of keeping records, the only year that has been drier is 1966 with 4.5 in. of precipitation. Lysimeters also have been unable to produce reliable samples and data. Only lysimeter 741-08-L1 has produced consistent samples for a short period but has failed to produce any water in the last two sampling rounds.

The amount of winter precipitation is another indicator of the amount of soil moisture available to increase subsurface moisture content. Snow typically accumulates in the winter and melts in spring, infiltrating into the soil when there is little evaporation usually providing one of the best opportunities for encountering soil moisture during the year. Precipitation that occurs in the summer has a much greater potential to be evaporated back into the atmosphere before infiltrating into the soil beyond the evaporation range. The winter precipitation for the last three years, 1999-2000, 2000–2001, and 2001-2002, has been 2.57, 1.8, and 2.63 in., respectively, well below the 51-year average of 3.27 in. See Figure 4, which shows the winter precipitation since 1951. Extremely dry conditions are a contributing factor in the performance of the lysimeters, tensiometers, and soil moisture probes.

a. Data for the Central Facilities Area weather station obtained from Neil Hukari at the National Oceanic and Atmospheric Administration.



03-GA50310-177

Figure 3. Annual precipitation at the Idaho National Engineering and Environmental Laboratory (Central Facilities Area).

Winter Precipitation at INED (CFA)

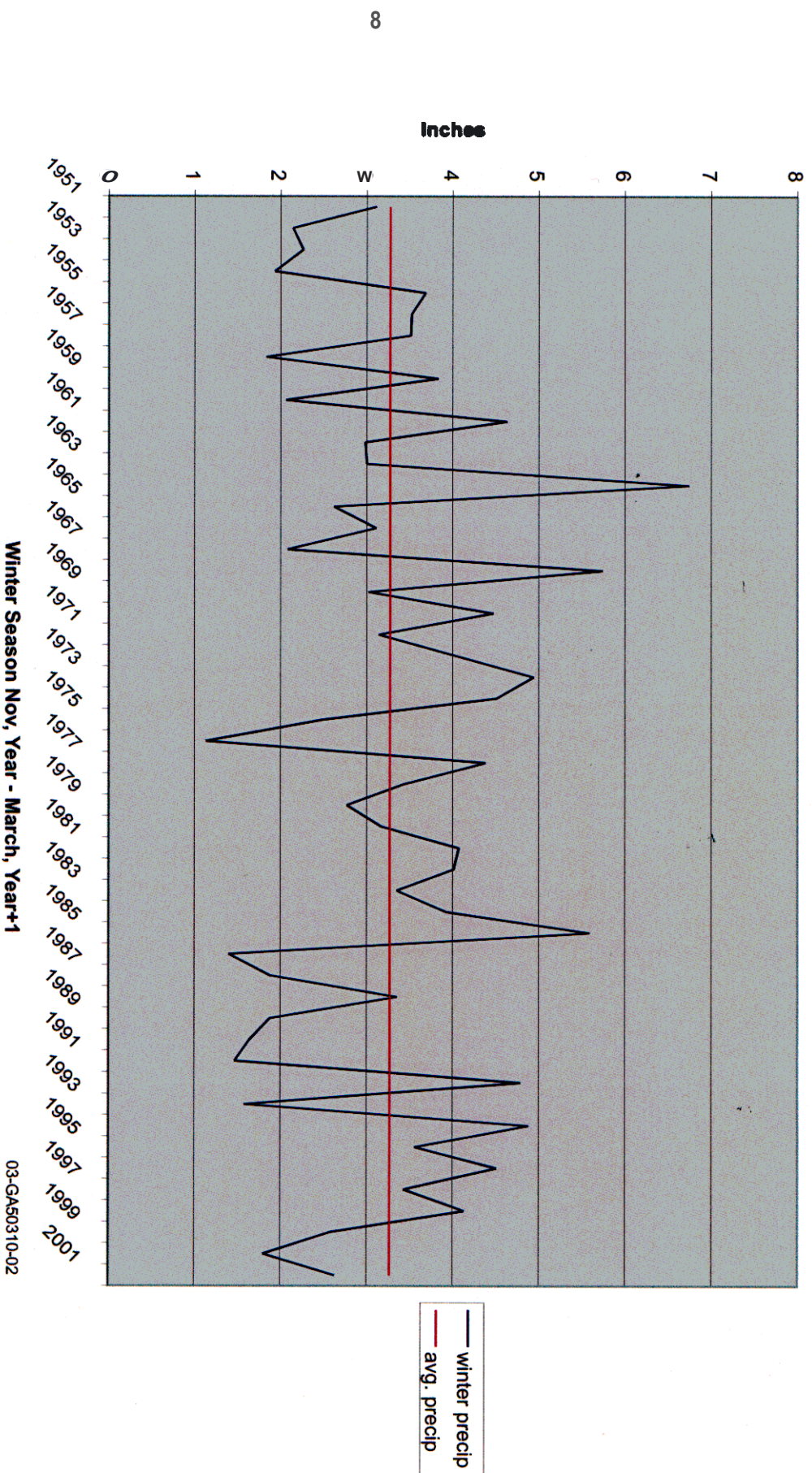


Figure 4. Winter precipitation at Idaho National Engineering and Environmental Laboratory (Central Facilities Area)

03-GA50310-02

2. SOIL VAPOR PROBE

2.1 Introduction

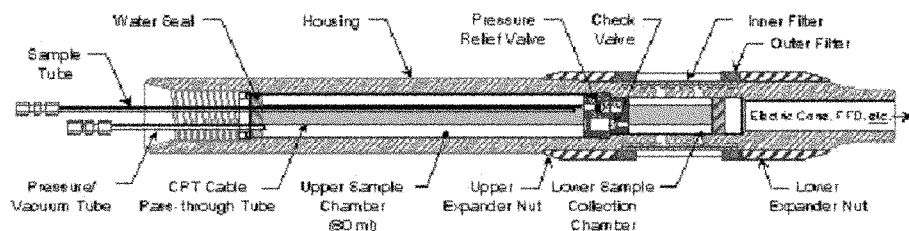
Between April and September of 2001, 29 Type B gas-sampling probes were installed in the SDA for the purpose of monitoring VOCs and the radionuclide gases C-14 (present in CO₂) and tritium (H-3) (present in water vapor). During FY 2002, some gas samples also were analyzed for O₂, H₂, CH₄, and CO₂ to determine reducing/oxidizing (redox) conditions in Pit 4 and Pit 10. The redox gas analysis was not part of the regular sampling and analysis schedule but was performed two times after the VOC analysis was performed.

This section contains a description of the probes, how and where they were installed, and a description of the sample collection methods. Subsequent sections contain a description of analysis methods, results, and a discussion of the results for each of the three analyte groups (VOCs, radionuclide, and redox gases).

2.1.1 Probe Description

OU 7-13/14 Integrated Probing Project Vapor Port Instrumented Probe (Anderson 2001) describes the vapor probes used at the SDA. The basic probe is called a conesipper and is manufactured by Vertek. A schematic of the Vertek conesipper is shown in Figure 5.

The body of the conesipper is made of 416 stainless steel. A series of O-rings and a compressible-gasket water seal, all made of Viton, provide at least two barriers to prevent gas or liquid from reaching the surface through any path other than the sample tubes. Internal gravity-operated valve seals at the bottom of the sample tube paths, also made of Viton, will provide the first barrier for this path. The second barrier is a valve at the other end of the tube at the surface. Two filters were incorporated to prevent particles from entering the probe sample chamber. The outer filter is a 254- μ stainless steel perforated cylinder. The inner filter is a 38- μ stainless steel screen attached directly behind a drive tip. The design allows soil gas samples to be collected above ground by applying a vacuum to the vapor-port line.



03-GA50310-23

Figure 5. Vertek conesipper cone penetrometer for soil gas sampling.

A segmented rigid pipe, referred to as a probe casing, was used to drive the instrumented probe into the ground and to provide conduit for the flexible internal tubing used to transfer gas samples to the surface. The casings, manufactured at the INEEL, have threaded joints to allow for quick assembly and double O-rings at each joint. The probes were pushed into place using a sonic drill rig and left as permanent installations. Caps, also manufactured at the INEEL, were placed on top of the casings to provide another layer of containment.

2.1.2 Probe Locations

Sixteen of the Type B vapor probes were placed in the 743 and depleted uranium focus areas (see Figures A-3 and A-4 in Appendix A) for monitoring VOC concentrations. Thirteen probes for monitoring the radionuclide gas C-14 were placed near Soil Vault Rows (SVRs)-12 and -20 (see Figure A-7). The four probes at SVR-20 also are sampled for H-3. Table 2 lists the vapor probes and includes information on locations and port depths. The table also lists whether or not a sample can be collected. Several of the installed vapor probes do not yield a sample. The reason is unknown, but it's possible some of the probes were damaged during installation, or the sampling port could have been pushed into a low-permeability material such as sludge.

2.2 Volatile Organic Compounds

2.2.1 Sample Collection Method

Type B vapor probe VOC samples are collected inside of a glovebag in accordance with "Glove Bag Supported Sample Acquisition from Type B Probes in the SDA" (TPR-1674). This TPR includes all aspects of acquiring VOC samples and the handling of the samples in the sample preparation facility. Inside the glovebag, samples are collected in either 1-L Tedlar bags or precleaned Summa canisters (250 mL or 6 L).

The Tedlar bags are filled by connecting them to a port on the inside of a vacuum chamber box that is connected to the vapor probe sample port. Vacuum is then applied to the vacuum chamber box, allowing the Tedlar bag to fill with soil gas. Summa canisters are filled by removing the vacuum chamber box and connecting the Summa canister directly to the vapor-port line inside the glovebag. The Summa canister is preevacuated so that when the valve on the canister is opened, the gas sample is drawn inside until the gauge reaches zero or until the preset time in the procedure (TPR-1674) has elapsed, whichever occurs first. A vacuum coupling radlab filter attached to the Summa canister is then surveyed for radiological contamination before shipping.

2.2.2 Sample Schedule

The original sampling schedule as outlined in the Type B Probe *Field Sampling Plan* (Salomon 2001) called for quarterly sampling until a baseline was established. According to this schedule, samples were collected from selected probes in November 2001 and February, June, and August 2002. However, to date, a baseline has not been established because of inconsistencies in some of the early data sets and initial problems with the Innova multigas analyzer. As these issues are resolved, quarterly sampling will continue until the project feels a baseline has been established for each location.

2.2.3 Analysis Methods

Type B vapor probe samples were analyzed with an Innova model 1314 photoacoustic multigas analyzer for the VOCs shown in Table 3. The table also contains the concentration range of the filters in the Innova analyzer.

Table 2. Type B vapor probe locations and port depths.

Probe Name	Port Depth (ft)	Yields a Sample	
743 Focus Area (Volatile Organic Compounds)			
743-03-VP1	18.0		No
743-03-VP2	13.3		No
743-03-VP3	4.8		No
743-08-VP1	20.2	Yes	
743-08-VP2	13.4	Yes	
743-08-VP3	4.9		No
743-18-VP1	20.0		No
743-18-VP3	7.6		No
743-18-VP4	14.6	Yes	
Depleted Uranium Focus Area (Volatile Organic Compounds)			
DU-08-VP2	15.8	Yes	
DU-10-VP1	11.6	Yes ^a	
DU-10-VP2	10.0	Yes	
DU-10-VP3	6.2	Yes	
DU-14-VP1	16.1		No
DU-14-VP2	11.7	Yes	
DU-14-VP3	4.9	Yes	
Soil Vault Row-12 (Carbon-14)			
SVR-12-1-VP1	11.7	Yes	
SVR-12-1-VP2	7.6	Yes	
SVR-12-1-VP3	2.7	Yes	
SVR-12-2-VP1	11.9	Yes	
SVR-12-2-VP2	7.7	Yes	
SVR-12-2-VP3	2.6		No
SVR-12-3-VP1	11.8	Yes	
SVR-12-3-VP2	7.6	Yes	
SVR-12-3-VP3	2.5	Yes	
Soil Vault Row-20 (Carbon-14 and Tritium-3)			
SVR-20-3-VP1	6.3		No
SVR-20-3-VP2	12.9		No
SVR-20-3-VP3	15.0		No
SVR-20-5-VP3	17.2	Yes	

a. Port was not functioning originally during the November 2001 sampling event but yielded a small sample volume during the February 2002 sampling event and appears to be working now.

Table 3. Volatile organic compounds analyzed by the Innova photoacoustic multigas analyzer and the filter concentration ranges.

Analyte	Formula	Optical Filter Range (ppmv)
Carbon tetrachloride	CCl_4	6 to 100,000
Chloroform	CHCl_3	1 to 10,000
Trichloroethene	C_2HCl_3	0.09 to 9000
Tetrachloroethene	C_2Cl_4	0.3 to 10,000
1,1,1-Trichloroethane	$\text{C}_2\text{H}_3\text{Cl}_3$	0.04 to 4000

The measurement principle of the Innova is based on the photoacoustic infrared detection method. The instrument can measure almost any gas that absorbs infrared light (e.g., most chlorinated solvents). The Innova compensates any measurement for temperature fluctuations, water-gas interference, and interferences from other gases known to be present.

Some of the field duplicate samples also were analyzed using standard laboratory gas chromatography/mass spectrometry (GC/MS) methods as an accuracy check on the Innova results. Samples were analyzed by Southwest Research Institute (SWRI) Laboratories, Southwest Laboratories of Oklahoma (SWLO), and the Environmental Chemistry Laboratory (ECL) at the INEEL. Other than the five compounds analyzed and detected using the Innova, the only other VOC positively identified through GC/MS analysis was the compound 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113) at concentrations up to 250 ppmv.

2.2.4 Results

The Type B vapor probe VOC sampling results are shown in Table 4. This table includes only the results that have been reviewed and accepted as representative by the project. During earlier stages of the project, problems were encountered resulting in some of the data being considered unreliable or suspect. Technical problems were found with both the Innova multigas analyzer and the results from offsite laboratories performing analysis of duplicate samples. The problematic data have been omitted from the table. An explanation of the issues surrounding the problems is discussed in the following section.

2.2.5 Discussion

Data analyzed using the Innova multigas analyzer before the February 2002 sampling round have been rejected for use by the project. During initial programming, calibration, and testing of the instrument by California Analytical Instruments (the U.S. distributor), a molecular weight of 1 was mistakenly entered for chloroform instead of the true value of 119.4. As a result, chloroform results were in error, and results for other compounds may have been compromised as well.

The instrument was returned to the INEEL in early February 2002 following reprogramming and extensive calibration checks performed by California Analytical Instruments. After being returned, calibration gas checks were performed by INEEL personnel. The results were all within acceptable limits.

Samples collected during February 2002 were analyzed by the Innova, and duplicate (co-located) samples were analyzed by an offsite lab, Southwest Research Institute. Results indicated significant lack of correlation between the field analytical results (using the Innova) and the GC/MS data generated by SWRI. At the time, it was assumed that the problem was likely with the field analyzer. As a result, the Innova was sent back to California Analytical Instruments for additional testing and calibration in late March 2002.

After extensive calibration checks, which included high-level carbon tetrachloride and multigas standards, California Analytical Instruments returned the Innova to INEEL, confident that the instrument

was performing well. On May 22, 2002, a meeting was held to discuss the path forward for the next round of sampling and address the problems from the previous sampling round. At this point, the project believed that there could have been mechanical issues associated with use of Summa canisters to collect the offsite duplicate samples or that there may have been a problem with the offsite laboratory analysis. To help solve this problem, project personnel decided to:

- Use an onsite lab (INEEL ECL) as a check using duplicate or split samples. The INEEL ECL performs VOC analysis for the Waste Isolation Pilot Plant 3100m³ Program and is considered an outstanding technical resource.
- Continue using SWRI for some duplicate analysis.
- Develop a specific order of sample collection to try and determine if result differences in the previous round were attributable to a sampling procedure or other phenomenon.

An extensive round of samples was collected from selected vapor ports in June 2002. There was excellent correlation between the Innova and ECL results but poor correlation with the **SWRI** results. Also, the ECL analyzed collocated samples collected in Summa canisters (250 mL and 6 L) and Tedlar bags. No significant differences were observed between results obtained from different sample collection devices or from order of sample collection. This indicated that it was unlikely that mechanical sampling issues existed.

On August 6, 2002, another meeting was held to discuss the results of the June sampling round. As a result of the apparent correlation problem with the SWRI data, project personnel decided to:

- Change the offsite laboratory performing duplicate analyses from SWRI to SWLO
- Get the INEEL ECL to support another round of duplicate analysis, which it was not able to do because of other commitments.

Another round of samples was collected in August 2002. This time, SWLO was used for analysis of collocated duplicate samples. Carbon tetrachloride results between the regular sample analyzed using the Innova and its duplicate analyzed by SWLO were again inconsistent as shown below:

Innova:	62,171 ppmv (regular)
Southwest Laboratories of Oklahoma:	20,000 ppmv (duplicate)
Innova:	63,732 ppmv (regular)
Southwest Laboratories of Oklahoma:	3 ppmv (duplicate)

The four samples above, along with others, were collected from the same vapor port (743-08-VP2). A final meeting was held on December 3, 2002, to determine how to proceed with all the irregularities and determine a path forward for the project. After reviewing statistical evaluations on the data sets and the other relevant information, the project team decided to:

b. C. M. Green, Idaho National Engineering and Environmental Laboratory, Letter to C. L. Harris, Idaho National Engineering and Environmental Laboratory, "OU 7-13/14 Integrated Probing Project Vapor Port VOC Summary of Data Usability Evaluations."

Table 4. Volatile organic compound gas concentration results from Subsurface Disposal Area vapor probes in 2002 that are considered valid.

Probe	Port Depth (ft)	Date Sampled	Lab	Sample Number	Sample Type	Container	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	TCA (ppmv)	TCE (ppmv)	PCE (ppmv)	Freon-113 (ppmv)
743-08-VP1	20.2	2/11/02	Innova	IPV05601VA	Regular	Tedlar bag	30233	22339'	974	3178	470	
		6/10/02	Innova	IPV10601VA	Regular	Tedlar bag	57466	22119	1881	9723	-800 ^d	
		6/10/02	Innova	IPV10602VA	Duplicate	Tedlar bag	58353	21910	1885	9868	-858	
		6/10/02	Innova	IPV10603VA	Duplicate	Tedlar bag	58337	21670	1873	9930	-886	
		6/10/02	INEEL ECL	IPV10601VA	Split	Tedlar bag	55000	20000	1600	12000	110 U	200
		6/10/02	INEEL ECL	IPV10602VA	Split	Tedlar bag	56000	21000	1700	13000	110 U	180
		6/10/02	INEEL ECL	IPV10602VT	Duplicate	Summa (250 mL)	59000	22000	1700	14000'	100 u	230
		6/10/02	INEEL ECL	IPV10603VA	Split	Tedlar bag	40000	15000	1100	9200	100 u	150
		6/10/02	INEEL ECL	IPV10603VT	Duplicate	Summa (250 mL)	59000	22000	1800	14000'	98 U	250
		6/10/02	INEEL ECL	IPV10604VT	Duplicate	Summa (6 L)	55000	21000	1600	14000'	88 u	200
		8/20/02	Innova	IPV15001VA	Regular	Tedlar bag	56070	22150	1805	9901	-802	
		8/20/02	Innova	IPV15001VA	Split	Tedlar bag	56140	22120	1818	10080	-856	
		11/20/02	Innova	IPV17101VA	Regular	Tedlar bag	44600	22200	1550	7080	-192	
743-08-VP2	13.4	2/11/02	Innova	IPV05701VA	Regular	Tedlar bag	36277	15405	918	1451	181	
		2/11/02	Innova	IPV05702VA	Duplicate	Tedlar bag	37782	15719	946	1441	170	
		6/12/02	Innova	IPV10701VA	Regular	Tedlar bag	54231	13618	1405	3106	53	
		6/12/02	Innova	IPV10702VA	Duplicate	Tedlar bag	53528	13183	1385	3044	49	
		8/27/02	Innova	IPV15601VA	Regular	Tedlar bag	62171	15372	1559	3405	78	
		8/27/02	Innova	IPV15601VA	Split	Tedlar bag	62592	15404	1571	3482	73	
		8/27/02	Innova	IPV15602VA	Duplicate	Tedlar bag	63732	15246	1573	3478	71	
		8/27/02	Innova	IPV15602VA	Split	Tedlar bag	64031'	15288	1584	3550	64	
		11/20/02	Innova	IPV17201VA	Regular	Tedlar bag	54800	15800	1480	3070	33	
		11/20/02	Innova	IPV17202VA	Duplicate	Tedlar bag	54500	15300	1460	2940	33	
743-18-VP4	14.6	2/12/02	Innova	IPV05801VA	Regular	Tedlar bag	8616	1385	231	1358	218	
		6/12/02	Innova	IPV10801VA	Regular	Tedlar bag	8904	1353	291	1621	68	
		8/15/02	Innova	IPV15701VA	Regular	Tedlar bag	11750	1490	387	2133	32	
		8/15/02	Innova	IPV15701VA	Split	Tedlar bag	11770	1500	390	2175	34	
		11/18/02	Innova	IPV17301VA	Regular	Tedlar bag	10800	1670	374	2070	66	
DU-08-VP2	15.8	2/13/02	Innova	IPV05101VA	Regular	Tedlar bag	11359	8559	2760	4957	924	
		6/11/02	Innova	IPV10101VA	Regular	Tedlar bag	12478	8571	3479	6626	2331	
		8/15/02	Innova	IPV15001VA	Regular	Tedlar bag	12750	8331	3618	7663	2203	
		8/15/02	Innova	IPV15001VA	Split	Tedlar bag	12470	8237	3594	7752	2256	
		11/18/02	Innova	IPV16601VA	Regular	Tedlar bag	12700	8190	3790'	8860	1960	
DU-10-VP1	11.6	2/12/02	Innova	IPV05901VA	Regular	Tedlar bag	941	434	136	360	136	
		6/11/02	Innova	IPV10901VA	Regular	Tedlar bag	1053	579	271	651	187	
DU-10-VP2	10.0	Feb-02	Innova	IPV05201VA	Regular	Tedlar bag	7026	1942	1610	3187	1648	
		6/10/02	Innova	IPV10202VA	Regular	Tedlar bag	6014	1995	1729	3408	1668	
		6/10/02	INEEL ECL	IPV10202VA	Split	Tedlar bag	6000	1000	1800	3800	1300	40

Table 4. (continued).

Probe	Port Depth (ft)	Date Sampled	Lab	Sample Number	Sample Type	Container	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	TCA (ppmv)	TCE (ppmv)	PCE (ppmv)	Freon-113 (ppmv)
		6/10/02	INEEL ECL	IPV10202VT	Duplicate	Summa (250 mL)	6200	1100	1700	3800	1300	40
		6/10/02	Innova	IPV10203VA	Duplicate	Tedlar bag	5626	1841	1668	3353	1752	
		6/10/02	INEEL ECL	IPV10203VA	Split	Tedlar bag	5100	850	1500	3200	1100	34
		6/10/02	INEEL ECL	IPV10203VT	Duplicate	Summa (250 mL)	5900	1000	1700	3900	1400	40
		6/10/02	Innova	IPV10204VA	Duplicate	Tedlar bag	5789	1882	1727	3483	1815	
		6/10/02	INEEL ECL	IPV10204VA	Split	Tedlar bag	5500	930	1600	3500	1300	39
		6/10/02	INEEL ECL	IPV10204VT	Duplicate	Summa (6 L)	4900	830	1500	3400	1300	34
		6/10/02	Innova	IPV10201VA	Regular	Tedlar bag	5787	1850	1721	3307	1777	
		8/20/02	Innova	IPV15101VA	Regular	Tedlar bag	7896	2701	2387	4266	2129	
		8/20/02	Innova	IPV15101VA	Split	Tedlar bag	7790	2696	2395	4327	2179	
DU-10-VP3	6.2	11/18/02	Innova	IPV16701VA	Regular	Tedlar bag	6220	1890	2220	4160	2070	
		2/12/02	Innova	IPV05301VA	Regular	Tedlar bag	11381	1719	1310	2098	1449	
		6/11/02	Innova	IPV10301VA	Regular	Tedlar bag	14051	1904	1992	3206	2205	
		8/15/02	Innova	IPV15201VA	Regular	Tedlar bag	17360	2485	2640	4259	2942	
		8/15/02	Innova	IPV15201VA	Split	Tedlar bag	17360	2496	2658	4339	3009 ^c	
DU-14-VP2	11.7	11/18/02	Innova	IPV16801VA	Regular	Tedlar bag	10200	1570	1880	2870	2160	
		2/12/02	Innova	IPV05401VA	Regular	Tedlar bag	6083	4515	1146	7263	724	
		6/11/02	Innova	IPV10401VA	Regular	Tedlar bag	6323	4524	1360	7884	365	
		8/15/02	Innova	IPV15301VA	Regular	Tedlar bag	7453	5212	1528	10090	-62	
		8/15/02	Innova	IPV15301VA	Split	Tedlar bag	7250	5240	1539	10300	-104	
DU-14-VP3	4.9	11/18/02	Innova	IPV16901VA	Regular	Tedlar bag	7300	5110	1650	10200	-51.9	
		2/12/02	Innova	IPV05501VA	Regular	Tedlar bag	1081	541	312	710	381	
		6/11/02	Innova	IPV10501VA	Regular	Tedlar bag	1558	1029	694	1612	810	
		8/15/02	Innova	IPV15401VA	Regular	Tedlar bag	2062	1466	902	2050	986	
		8/15/02	Innova	IPV15401VA	Split	Tedlar bag	2027	1471	908	2086	1015	
		11/18/02	Innova	IPV17001VA	Regular	Tedlar bag	840	571	449	1020	546	

ECL = Environmental Chemistry Laboratory
PCE = tetrachloroethene

Freon-113 = 1,1,2-trichloro-1,2,2-trifluoroethane
TCA = 1,1,1-trichloroethane

INEEL = Idaho National Engineering and Environmental Laboratory
TCE = trichloroethene

c. Maximum measured concentration

d. Negative results are considered undetected

- Consider all Innova data processed before February 2002 as suspect, and reject them for normal use
- Consider all Innova data processed from February 2002 on as acceptable for use unless limited or rejected by future data validation processes
- Consider all INEEL ECL VOC data as acceptable unless limited or rejected by future data validation processes
- Consider all SWRI VOC data collected for this project as rejected by the project for future use
- Consider the SWLO VOC data collected in August 2002 as suspect, and consider this for rejection depending on the results of Innova/SWLO duplicate analysis pending from a November 2002 sample round.

Regarding the valid (not rejected) results, the highest concentrations of carbon tetrachloride, chloroform, and trichloroethene were measured at location 743-08. The highest concentrations of 1,1,1-trichloroethane and tetrachloroethene were measured at the depleted uranium location. These concentrations are much higher than any other previous soil gas measurements at the SDA, which should not be surprising since the samples were taken from the pits. These high-VOC concentrations indicate the presence of nonaqueous phase liquid VOCs likely bound up in the Series 743 sludge. Table 5 compares the maximum measured VOC concentrations to that of pure component equilibrium gas concentrations and the equilibrium gas concentrations at the estimated mole fractions in the original Series 743 sludge mixture. The gas concentrations of the mixture are lower because the partial gas pressures of the mixture are lower than for a pure component.

Although the maximum measured concentrations are very high, they are still a fraction of the pure component equilibrium gas concentrations. However, they are close to the equilibrium gas concentrations at the estimated mole fractions in the original Series 743 sludge mixture. In fact, the maximum trichloroethene and tetrachloroethene concentrations are greater than the estimated equilibrium gas concentrations of the mixture. If it is assumed that the mole fractions of the mixture after 30+ years of burial have not changed from the original mixture, which is appropriate for a rough comparison, the maximum measured gas concentrations indicate some VOCs are still present in the sludge. An estimate of the mass of VOCs remaining is crucial to any remediation of the SDA. Nuclear logging for chlorine and soil vapor sampling has been key to developing this estimate. The presence of VOCs is supported by the a recent study by Miller, which estimates that approximately 50% of the original VOCs could be remaining in the burial pits.'

2.2.6 Conclusions and Recommendations

Valid sample results indicate VOCs are present in the source pits at concentrations comparable to those predicted to be in equilibrium with Series 743 sludge. This suggests Series 743 sludge containing VOCs still remains in the pits. Further monitoring is necessary to determine trends in release rate, which can be used to validate numerical models and estimate the persistence of the source.

c. INEEL, 2003, *Preliminary Estimate of Carbon Tetrachloride and Total Volatile Organic Compound Mass Remaining in the Subsurface Disposal Area Pits (Draft)*, INEEL/EXT-02-00140, Rev. 0, Idaho National Engineering and Environmental Laboratory.

Table 5. Volatile organic compound pure component equilibrium gas concentrations and equilibrium gas concentrations at estimated mole fractions of original Series 743 sludge mixture (temperature assumed 25°C).

Volatile Organic Compound	Vapor Port	Maximum Measured Gas Concentration (ppmv)	Pure Component Equilibrium Gas Concentration (ppmv)	Estimated Mole Fraction of Volatile Organic Compounds in Original Series 743 Sludge Mixture"	Equilibrium Gas Concentration of Volatile Organic Compounds in Series 743 Sludge Mixture (ppmv)
Carbon tetrachloride	743-08-VP2	64,031	143,000	0.65	93,000
Chloroform	743-08-VP1	22,339	255,000	NA ^b	NA ^b
1,1,1-trichloroethane	DU-08-VP2	3,790	165,000	0.07	12,000
Trichloroethene	743-08-VP1	14,000	99,000	0.08	8,100
Tetrachloroethene	DU-10-VP3	3,009	25,000	0.07	1,800

a. Balance of mole fraction made up of Texaco Regal Oil
b. Chloroform not a component of Series 743 sludge

2.3 Oxygen, Hydrogen, Methane, and Carbon Dioxide

2.3.1 Sample Collection Methods

Samples were collected using 6-L Summa canisters as described in Section 2.2.1.

2.3.2 Analysis Methods

SWRI Laboratory samples were analyzed by gas chromatography/pulsed discharge-helium ionization detector air analysis for O₂, H₂, CH₄, and CO₂.

Bechtel BWXT Idaho, LLC, Environmental Chemistry Lab samples were analyzed by gas chromatography/thermal conductivity detector for H₂ and CH₄.

2.3.3 Discussion

Since November 2001, samples have been collected for redox gas analysis. Measurement of redox gas concentrations (oxygen, hydrogen, methane, and carbon dioxide), along with the VOC monitoring being performed, is providing valuable input for the feasibility study and subsequent remedial design. It appears that carbon tetrachloride is being reductively dechlorinated to chloroform in the subsurface at the **SDA** as indicated by the presence of chloroform where only a very small amount of chloroform was believed to have been disposed of. The mechanism for this reduction has not been understood, and in-situ destruction of chlorinated solvents has not been included in risk assessment calculations to date. The destruction of carbon tetrachloride is facilitated by the presence of hydrogen gas as an electron donor. Hydrogen gas has been detected in the probes in the organic sludge focus area (a.k.a. 743 sludge focus area). This provides a mechanism for the transformation of carbon tetrachloride and chloroform to less toxic compounds.

In addition, actinide elements are significantly less soluble under reduced conditions, where they are in the +IV valence state, than in the presence of oxygen where they are more likely to be present in the +V or +VI valence state. Solubility is an important component of the source-term release model in the disposal unit source-term code. Solubility limited release of actinides will depend on the redox conditions in the waste. Methane and hydrogen gas in the 743 sludge focus area indicates areas of reducing conditions in the pit. The difference in solubility between oxidized uranium and reduced uranium is about a factor of 100.

Measurement of the redox gases provides a relatively simple and inexpensive means of determining the oxidation state of the buried waste indirectly. From knowledge of the redox state, biogeochemical processes controlling waste transformation and mobility can be identified. These processes can be included in the source-term model for evaluating the effectiveness of remedial alternatives.

Though useful data are being gathered to evaluate redox conditions in the pits, there are several problems with the existing data set given in Table 6. Limitations with the data and the proposed path forward are discussed below. On January 29, 2003, a meeting was held to discuss the redox gas data collected to date and determine a path forward. cursory reviews of the data set have indicated problems with some of the data. Indicators that problems exist include that some of the oxygen data contain results considerably above atmospheric oxygen levels, which has been deemed implausible. Results from some of these same probes show oxygen levels at either near or greatly below atmospheric oxygen levels during other sampling events.

During the January 12 meeting, it was decided:

- All February 2002 SWRI data collected for O₂ analysis were rejected for project use because numerous results were above 210,000 ppmv (21%), which was deemed implausible. It was surmised that the problem could be a result of a faulty dilution procedure.
- All February 2002 SWRI data collected for CO₂ analysis were rejected for project use because a dilution procedure was used to obtain CO₂ results and that procedure may (from what was surmised in the O₂ analysis) be a source of error.
- Methane and H₂ analyses results from the same time period and lab were reviewed, but there is not enough information to be able to evaluate the data.
- Results from the November 2001 sampling could not be evaluated with the limited data set.

Data that are assumed to be unusable (rejected for use by the project) are indicated in Table 6 by a strikeout through the result.

2.3.4 Conclusions and Recommendations

The analysis of redox gases can benefit the WAG 7 environmental process, and the following changes are recommended to support the WAG 7 remedial investigation/baseline risk assessment/feasibility study program. Like the VOC analysis described in the previous section, the project has recognized problems that seem to exist with some of the analysis being performed by some offsite contract laboratories. To mitigate these problems, the use of the proven INEEL ECL laboratory to perform H₂ and methane analyses is proposed. It also is proposed that industry standard field analyzers for O₂ and CO₂ analyses be procured. Use of quality assurance checks, such as calibration gas checks, will be incorporated into use of field analyzers. The collection of redox gas samples from all functioning Type B vapor ports should be added to existing work plans to give a more complete understanding of the distribution of redox gas conditions at a given time. By collecting information on the oxidation and reduction conditions in the buried transuranic waste (TRU) and documenting conditions conducive to reductive dechlorination of the chlorinated methanes, additional remedial action alternatives may become available, which could reduce the overall cost of remediating the SDA.

2.4 Carbon-14 and Tritium

2.4.1 Sample Collection Method

Carbon-14 samples are withdrawn from the probes using a peristaltic pump connected directly to the port and collected in 1-L Tedlar bags. At SVR-20, the relatively high concentrations of H-3 require

the soil gas be passed through a gas-washing bottle filled with dilute acid. This typically removes over 99% of the H-3 present in the sample gas while allowing the CO₂ to pass through to the Tedlar bag.

H-3 samples were originally to be collected using a programmable low-flow air sampler to pull soil gas through a desiccant bed. However, the single probe in SVR-20 that does yield a sample requires more vacuum than can be generated by the programmable H-3 sampler. Therefore, a new approach is being developed for sampling H-3. The new approach will likely call for a more powerful pump (e.g., capable of one standard lpm at 1 psia).

ports in the Surface Disposal Area.

Date Sampled	Lab	Sample Number	Container	Probe	Port Depth (ft)	CO ₂ (ppmv)	Hydrogen (ppmv)	Oxygen (ppmv)	Methane (ppmv)
2/11/2002	SWRI	IPV05601VT	6-L Summa canister	743-08-VP1	20.2	461 D	264	282,616 D, B	64 U
6/10/2002	SWRI	IPV10601VT	6-L Summa canister			3,190 J	1,790	154,000 J	63.2 J
	INEEL ECL	IPV10601VA	Tedlar bag				12,210	56,840 B	690 J
	INEEL ECL	IPV10602VA	Tedlar bag				12,550	51,920 B	700 J
	INEEL ECL	IPV10602VT	250-mL Summa canister				12,930	56,200 B	690 J
	INEEL ECL	IPV10603VA	Tedlar bag				12,340	54,650 B	720 J
	WEELECL	IPV10603VT	250-mL Summa canister				13,130	57,030 B	690 J
	WEEL ECL	IPV10604VT	6-L Summa canister				10,300	94,190 B	270 J
2/11/2002	SWRI	IPV05701VT	6-L Summa canister	743-08-VP2	13.4	1,515 D	1,909 D	258,602 E, B	62 U
	SWRI	IPV05702VT	6-L Summa canister			7,911 D	5,243 D	452,377 D, B	196
8/27/2002	SWLO	IPV15601VT	6-L Summa canister			2,280		6,990	73
	SWLO	IPV15602VT	6-L Summa canister					3,220	1 U
11/20/2002	SWLO	IPV17201VT	6-L Summa canister			2,000 J		19,000	177.7
	SWLO	IPV17202VT	6-L Summa canister			2,000 J		11,000	305
2/12/2002	SWRI	IPV05801VT	6-L Summa canister	743-18-VP4	14.6	55,997 D	337	94,055 D, B	58 U
11/14/2001	SWRI	IPV00201VT	6-L Summa canister	DU-08-VP2	15.8	569 D	90	3,145 D, B	62 U
2/13/2002	SWRI	IPV05101VT	6-L Summa canister			521 D	574	445,275 D	64 U
2/12/2002	SWRI	IPV05201VT	6-L Summa canister	DU-10-VP2	10.0	801 D	58 U	640,570 E, B	58 U
6/10/2002	SWRI	IPV10201VT	6-L Summa canister			2,730 J	159 J	183,000 J	400 U
	WEEL ECL	IPV10202VA	Tedlar bag				80 U	157,210 B	30 U
	WEELECL	IPV10202VT	250-mL Summa canister				90 U	159,840 B	30 U
	INEEL ECL	IPV10203VA	Tedlar bag				80 U	156,770 B	30 U
	INEEL ECL	IPV10203VT	250-mL Summa canister				80 U	158,330 B	30 U
	INEEL ECL	IPV10204VA	Tedlar bag				80 U	177,640 B	30 U
	INEEL ECL	IPV10204VT	6-L Summa canister				250 U	241,260 B	80 U
11/14/2001	SWRI	IPV00101VT	6-L Summa canister	DU-10-VP3	6.2	1,073 D	118	3,066 D, B	62 U
2/12/2002	SWRI	IPV05301VT	6-L Summa canister			273	60 U	444,369 E, B	60 U
2/12/2002	SWRI	IPV05401VT	6-L Summa canister	DU-14-VP2	11.7	7,765 D	1,077	215,557 D, B	61 U
	SWRI	IPV05501VT	6-L Summa canister	DU-14-VP3	4.9	675 D	59 U	293,237 E, B	59 U

SWLO = Southwest Laboratories of Oklahoma

2.4.2 Sample Schedule

Currently, C-14 samples are collected quarterly from the functioning Type B vapor probes at SVR-12 and SVR-20. The *Field Sampling Plan* (Salomon 2001) calls for quarterly sampling for H-3 from the SVR-20 probes, but this has not been possible.

2.4.3 Analysis Methods

The C-14 samples are analyzed for C-14 specific activity (the C-14 activity per unit mass of total carbon). This requires analysis for total carbon and total C-14 activity in the gas sample. Total carbon is determined using gas chromatography to measure CO₂ concentration in the sample and by measuring the total sample volume with a 1-L gas syringe. The CO₂ in the sample is absorbed into approximately 12 mL of 0.5 normal NaOH solution (actual concentration is not critical) that is injected into the bag. Approximately 10 mL of the NaOH solution is recovered from the bag, mixed with a compatible liquid scintillation cocktail, and counted. Actual amounts of solutions used or transferred are determined gravimetrically. Liquid scintillation counting is performed (typically, 16-hour count times) using a Wallac quantalus. The Wallac is preferred for low-level samples such as those from SVR-12. National Institute for Standards and Technology-traceable C-14 standards (as sodium carbonate) prepared with 0.5 normal NaOH are used to evaluate the counting efficiency.

2.4.4 Results

Carbon-14 results for the functioning probes at SVR-12 and SVR-20 are contained in Table 7

Table 7. Specific activity of Carbon-14 (pCi C-14/g C) from soil vault row vapor probes.

Date	SVR-12-1-VP1	SVR-12-1-VP2	SVR-12-1-VP3	SVR-12-2-VP1	SVR-12-2-VP2	SVR-12-3-VP1	SVR-12-3-VP2	SVR-12-3-VP3	SVR-20-5-VP3
12/03/01	220	190	460	120	240	190	170	500	8.3E+04
2/20/02	2050	450	14900	1400	—	2000	1500	16300	2.8E+04
5/23/02	990	990	2820	1370	310	1220	1620	370	3.1E+4
8/13/02	871	341	26500 ^a	494	494	436	3090	1240	2520 ^a
11/13/02	711	556	327 ^b	1510	594	1110	677	1430 ^b	23800

a. It is possible the SVR-20-5-VP3 probe results were switched with the SVR-12-1-VP3 results.

b. Relative uncertainty >33%. The relative uncertainty of the other results is typically 5–10%. Also, the CO₂ concentrations in these samples are relatively low.

2.4.5 Discussion

Routine sampling of soil gas for C-14 began in FY 2002. The Tedlar bag sampling method was still in development during the first half of FY 2002, so the results are generally qualified because of limitations of the counting instrumentation. The first sample set was used to evaluate the relative performance of the Wallac quantalus and the Beckman LS-6000 liquid scintillation counters. The Wallac was expected to have considerably better low-level counting performance and, in fact, is required for sufficiently sensitive analysis of C-14 activity. The second sample set (collected February 20, 2002) was not analyzed with the Wallac, but the Wallac was used for subsequent sample sets.

The results for C-14 analysis of SVR-12 samples indicate that the C-14-specific activity is substantially elevated (on the order of 100X) above the naturally occurring level of 6.5 pCi/g C. The concentration of H-3 in soil gas near SVR-12 was measured and determined to be less than 600 pCi/L and probably considerably less than 100 pCi/L (i.e., near or at natural background levels). The absence of

tritium in the soil gas indicates that the C-14 originates from activated carbon steel rather than activated beryllium. This fulfills a major planning objective for this project: the SVR-12 results are intended to be representative of releases from activated stainless steel.

2.4.6 Conclusions and Recommendations

Although the specific activity of C-14 in CO₂ from soil gas near activated steel is elevated by approximately two orders of magnitude relative to natural levels, the C-14 activity contained in a typical 1-L bag sample is on the order of 1 pCi. Low-level liquid scintillation counting methods are required for C-14 analysis of the SVR-12 samples. The C-14 bag method appears to be well suited for characterizing C-14 in SDA soil gas, provided the Wallac quantulus is used for C-14 assay. The method development work should be documented in an engineering design file, which would serve as the basis for writing a standard procedure for routine work. As expected, the concentration of C-14 in soil near activated steel is much less than the concentration observed near activated beryllium. The relatively low concentration of H-3 at SVR-12 confirms that the SVR-12 location is not affected by H-3 migration from other sources (i.e., activated beryllium) and suggests that the location is not affected by C-14 from buried beryllium. If possible, some additional soil gas samples should be taken at other SDA locations to confirm that the SVR-12 C-14 results are representative of buried activated steel rather than of broadly distributed C-14 contamination.